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Characterization of Individual Radiographic Features of Hip Osteoarthritis in African American and White Women and Men: The Johnston County Osteoarthritis Project

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Abstract

OBJECTIVE—To describe differences in radiographic features of hip osteoarthritis (OA) between African American (AA) and white men and women.

METHODS—We conducted a cross-sectional analysis of radiographic hip OA using baseline data from The Johnston County Osteoarthritis Project, using Kellgren-Lawrence grade, and the presence, location, and severity of 4 individual radiographic features (joint space narrowing (JSN), subchondral cysts and sclerosis, and osteophytes (OST)). Gender-specific logistic regression was used to evaluate associations between race and individual radiographic features, adjusting for age, BMI, education, and prior hip injury. Robust variance estimators via generalized estimating equations (GEE) were used to account for correlation between hips from the same individual.

RESULTS—The sample (n=2,739) included 57% women and 31% AA participants. Among women, AAs and whites had a similar prevalence of hip OA, defined as K-L grade ≥ 2 (23% vs. 22%), but AA women were significantly more likely to have superior or medial JSN, moderate or severe axial JSN, medial or lateral OST, and subchondral cysts.

Among men, 21% of AA and 17% of white men had hip OA; AA men were more likely to have superior or medial JSN and lateral OST, but less likely to have axial JSN.

CONCLUSIONS—Individual radiographic features and patterns of hip OA differ by race among women and men, suggesting the possibility of anatomic and/or developmental variation in the hip joint. AAs have an increased frequency of features that have been predictive of hip replacement in other populations, a finding worthy of further study.

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The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Osteoarthritis (OA) is a common, chronic medical condition with ever increasing effects on the aging population. Over 21% of the adult U.S. population was affected by self-reported doctor-diagnosed arthritis in 2003-2005, primarily OA, with 8.8% experiencing arthritis-related activity limitation (1). These numbers are expected to increase to 25% and 9.3%, respectively, by 2030 (2). OA of the weight-bearing joints is a particularly important type of arthritis due to effects on mobility, and led to 96.8% of the 455,000 knee and 82.5% of the 233,000 hip replacement operations in the United States in 2004 (3).

There are known differences in radiographic hip OA by gender (4-7), and differences by race have been identified as well. While previous estimates of hip OA prevalence among native African populations have been low compared to whites (8,9), the frequency of hip OA is higher among Americans of African descent compared to native African populations (10-12). Although total hip replacement rates are lower among African Americans (AAs) compared to whites (10,13), it cannot be assumed that this reflects a lower prevalence of hip OA among AAs, since AAs are also less likely to undergo knee replacement (14), despite having equal or higher rates of knee OA compared to other groups (15). Most studies of hip OA are based on Kellgren-Lawrence (K-L) grade, a global assessment combining features such as joint space narrowing, subchondral cysts and sclerosis, and osteophytes. However, this global assessment does not distinguish between medial and lateral involvement, and places emphasis on osteophytes over other radiographic features, especially in the less severe categories. When evaluating the individual features of radiographic OA (rOA) at the knee, our group identified differences between AA and white individuals beyond those seen for K-L grade (15), but similar studies have not been done for the hip.

Among elderly white women, individual radiographic features of hip OA, including osteophytes (OST) and joint space narrowing (JSN), were predictive of hip OA progression in the Study of Osteoporotic Fractures (16). Both the location of OST in the hip joint and the pattern of JSN had impact on the odds of any radiographic progression and the odds of progression to hip replacement surgery (16). Therefore, these individual features, along with others, may be more useful than the global K-L grade in understanding the disease course of rOA at the hip, and any differences by race may provide similarly important prognostic information. The purpose of this study was to evaluate differences by race among men and women in regards to individual radiographic features of hip OA, after accounting for differences in demographic and clinical factors.

Patients and Methods

The study sample was drawn from the Johnston County Osteoarthritis Project (JoCo OA), an ongoing population-based study of OA in a rural North Carolina county. The recruitment of participants and overall project design are detailed elsewhere (17). Briefly, JoCo OA is a prospective longitudinal cohort study of knee and hip OA in civilian, non-institutionalized, AAs and whites, aged 45 years and older, who were residents of one of six townships in Johnston County for at least one year, and who were capable of completing the study protocol, consisting of home interviews and clinic visits. The current analysis is cross-sectional, utilizing data from the baseline evaluation (May 1991 to December 1997). The study was approved by the Institutional Review Boards of the University of North Carolina Schools of Medicine and Public Health, and the Centers for Disease Control and Prevention; all participants provided written informed consent prior to enrollment.

Categorization of racial group, educational attainment, and prior hip injury, assessed separately for right and left hip, were by self-report. Body mass index (kg/m^2) was calculated from weight (kg) and height (cm) measured during clinic visits. All men, and women fifty years of age and older, had a supine anterior-posterior pelvic film, taken with

the feet in 15 degrees of external rotation. As women under 50 years of age did not have pelvic radiography to avoid pelvic radiation, they were not included in the current analysis. Hip radiographs were read without knowledge of participant clinical status by a single radiologist (JBR) using the K-L radiographic atlas for overall hip radiographic grades (18). As previously described, inter- and intra-rater reliability for this reader are high (κ=0.859 and 0.886, respectively) (19). Radiographs scored as K-L grade 0 (normal) showed no radiographic features of OA; K-L grade 1 (questionable) included a small osteophyte of doubtful significance. Radiographs showing an osteophyte but no joint space narrowing were assigned K-L grade 2 (mild); moderate joint space narrowing was graded K-L 3 (moderate); K-L grade 4 (severe) was assigned if severe joint space narrowing was present, along with subchondral bone sclerosis (18). Hip rOA was defined as a K-L grade of 2 or more in at least one hip; unilateral or bilateral involvement was also evaluated.

Four individual features of hip OA were assessed, including JSN (superior, axial, or medial, as defined by Lanyon, et al (6)), subchondral cysts (either femoral or acetabular), sclerosis (either femoral or acetabular), and OST (medial and lateral, acetabular and/or femoral). OST and JSN were graded for severity based on the Burnett atlas (20): a normal joint was designated grade 0, mild involvement as grade 1, moderate as grade 2, and severe involvement as grade 3; due to small numbers in the severe group, the moderate and severe categories were combined for analysis. Sclerosis and cysts were graded as present or absent.

Statistical analyses

Statistical analyses were conducted using SAS version 9 (SAS Institute, Cary, NC). Means of continuous variables were compared using Student's T-test, while proportions were compared using Chi-squared tests, or Fisher's exact test as appropriate. All analyses were stratified by gender, based on known significant differences between men and women. For each gender, binomial and multinomial multiple logistic regression models were used to evaluate associations between race and the presence, location, or severity of individual radiographic features. Binomial logistic models were used for binary characteristics such as the presence or absence of sclerosis.

For ordinal outcomes such as the severity of JSN, proportional odds models were initially used to assess evidence of consistently increasing odds of severity with selected covariates (the proportional odds assumption). A proportional odds model assumes that the relationship between the independent variable of interest and levels of outcome are similar across successively more severe levels of the outcome, generating a single odds ratio describing the comparison between the best category and the other categories combined, and between the best category plus the middle category, compared to the worst category. This is in contrast to a multinomial logistic model, which generates an odds ratio for each comparison between the referent and every other category. In the case that the proportional odds assumption is satisfied, a single odds ratio can represent the odds across all levels of a variable. However, if the proportional odds assumption is not met, then the relationship between the independent variable and the outcome varies by level of the outcome. An example of this would be if the odds for a mild level of severity were lower among AA , but higher in AA for the mod/severe level. In this case, separate odds ratios must be used for each outcome level. Multinomial logistic models were used to assess the association of predictors with each category of nominal outcomes or ordinal outcomes for which the proportional odds assumption was not met. Models were adjusted for covariates of age, body mass index (kg/m^2, BMI), education (<12 years vs. ≥ 12 years), and prior hip injury. Robust variance estimators via generalized estimating equations (GEE) were used to account for correlation between hips from the same individual.

Results

Data from 3,187 individuals were assessed; after exclusion of women under 50 years of age, individuals with evidence of inflammatory disease (on hip or knee radiographs) or bilateral hip joint replacement, and those missing K-L grades (including 24 with unilateral joint replacements), 2,739 participants (1,184 men and 1,555 women) remained for analyses (Figure 1). Of the analyzed individuals, 57% were women and 31% were AA.

Characteristics of the sample, stratified by sex, are shown in Table 1. The mean age was higher among women than men, due to the exclusion of women under 50 years of age, with no significant differences in age between racial groups by sex. AA women had a significantly higher mean BMI compared to White women; White men had a higher BMI compared to AA men. More white men and white women (66% and 60%, respectively) had a high school education or beyond, compared to AA men and women (46% and 45%, respectively). There was no difference by race for history of prior hip injury among men or women.

WOMEN

AA and white women had a similar prevalence of rOA, defined by K-L grade ≥ 2 in at least one hip (23% vs. 22%). No differences were seen between white and AA women by specific K-L grades (p=0.14, Figure 2). Unilateral disease was more common than bilateral in both groups of women, with no difference by race (p=0.64). In unadjusted analyses, significant differences were identified in several of the radiographic features. Mild axial JSN was seen more frequently among White compared to AA women (26% compared to 20%), and while AA women had more frequent moderate/severe axial JSN, this finding was quite rare in both groups (1-2% affected, Table 2). AA women had more frequent superior JSN, and slightly higher frequencies of medial JSN, although the numbers for medial JSN were small and not significantly different by race. AA women had a slightly higher frequency of subchondral cysts, but there was no racial difference for sclerosis (Table 2). AA women had an increased frequency of medial OST, especially on the femoral side of the joint, compared to white women (Table 3). Lateral OST were also more frequent among AA women, and more often on the acetabular side, compared to white women. The combination of both acetabular and femoral OST was also increased in AA compared to white women, both laterally and medially. When assessed across the entire joint without separating lateral from medial, AA women were more likely to have OST in any site (acetabular only 47.1%, femoral only 5.1%, or both 16.0%) compared to White women (42.5%, 3.6%, and 13.2%, respectively, p<0.001).

In adjusted analyses, no significant differences were seen between AA and white women for K-L grade or laterality (data not shown). After adjustment, estimates did not significantly change from unadjusted models (Table 4). For axial JSN, where the proportional odds assumption did not hold, AA women had more than twice the odds of moderate or severe axial JSN compared to whites, with mild disease 30% less likely among AA women. The proportional odds ratio for superior JSN indicated that AA women were 70% more likely to have superior JSN, and to have it be more severe, compared to white women. Results were similar for medial JSN, but did not reach statistical significance, likely due to the infrequency of this pattern of JSN. The odds of having subchondral cysts were 50 % higher for AA women, but sclerosis did not differ by race (Table 4). AA women had 40% increased odds for more frequent and severe medial OST compared to white women, with twice the odds of medial femoral OST alone, but there were no significant differences by race for medial acetabular OST alone or for the combination of both medial femoral and medial acetabular OST in the adjusted analyses. AA women had more frequent and severe lateral OST compared to white women, and had 30% increased odds for the combination of lateral

femoral and acetabular OST, with no differences for isolated femoral OST or acetabular OST in the lateral compartment. For overall pattern of OST, without separation into lateral and medial compartments, AA women were 30% more likely to have acetabular only OST, 80% more likely to have femoral OST alone, and 50% more likely than White women to have both acetabular and femoral OST (data not shown).

MEN

Among the men, 17% of white and 21% of AA men had a K-L grade ≥ 2 in at least one hip, with most of the difference in the milder categories (p=0.02, Figure 2). In unadjusted analyses, unilateral disease was more common than bilateral in both groups, with no difference by race (p=0.08). AA men had a lower frequency of mild axial JSN compared to white men (Table 2). Similar to findings in the women, AA men had more frequent superior JSN than white men. There were no differences by race in medial JSN for the men, as the numbers of affected men were very small. There was no difference by race for the frequency of subchondral cysts, but AA men had a slightly higher frequency of sclerosis than did white men (Table 2). While the men had similar frequencies of medial OST, AA men had significantly more frequent and more often severe lateral OST, especially on the acetabular side of the joint (Table 3). Again similar to findings for the women, the combination of both acetabular and femoral OST was more frequent among AA compared to white men, but only on the lateral side of the joint. When OST were assessed across both medial and lateral compartments, AA men more frequently had acetabular only (36.6%) and both acetabular and femoral OST (19.1%) compared to White men (33.4% and 13.0%, respectively, p<0.001).

In adjusted analyses, despite a trend toward a difference by race for K-L grade ≥ 2 (OR 1.3, 95% CI 1.0, 1.8), there were no differences by specific K-L grades (and therefore by global OA severity) at the hip among men (data not shown). AA men were, however, more likely to have bilateral hip rOA compared to White men (OR 1.4, 95% CI 1.0, 1.8). As in the women, unadjusted and adjusted models did not significantly differ, and adjusted ORs are presented (Table 4). Compared to white men, AA men were significantly less likely to have mild axial joint space narrowing; no differences by race were seen for moderate/severe axial JSN. AA men had twice the odds of more frequent and severe superior JSN compared to white men. There was a borderline significant racial difference in medial JSN among the men, but very few men in either group had this pattern of JSN, and the model fit was questionable. No significant racial differences were seen among men for sclerosis or subchondral cysts. Medial OST also did not differ significantly by race among the men; no differences were seen for medial acetabular or medial femoral OST alone or for the presence of OST on the acetabular or femoral side of the joint in the medial compartment. However, and similarly to the women, AA men had about 40% higher odds of having, and having more severe, lateral OST, with 80% increased odds for the combination of both femoral and acetabular OST on the lateral side, and 40% increased odds for isolated lateral acetabular OST, with no difference for isolated femoral OST. Finally, when OST were considered regardless of medial or lateral compartment, AA men were 40% more likely to have acetabular only OST, and 80% more likely to have both acetabular and femoral OST, compared to White men (data not shown).

Discussion

This study reveals several differences between African American and white participants in specific radiographic features of hip OA, providing additional information beyond the global assessment provided by K-L grading. We again saw a comparable frequency of hip rOA among African Americans and whites, in line with more recent estimates (11,12). Hips of AA men and women demonstrated an increased frequency and severity of superior JSN

compared to hips of white men and women. AA men and women had less mild axial JSN than white men and women, and AA women had more moderate and severe axial JSN than white women. These findings suggest that there may be basic anatomic or biomechanical differences by race leading to variations in the pattern of rOA. Cysts and sclerosis showed less variation by race than did other characteristics, although AA women were more likely to have subchondral cysts than white women. OST were overall more frequent in AA compared to white participants, especially in the lateral compartment, and for the combination of both acetabular and femoral OST, suggesting that there was more bone formation among AA participants.

While it is not immediately evident why there are differences in specific radiographic features by race, there are several possibilities. Our estimates did not change after adjustment for standard confounders, including age, body mass index, education, and prior injury to the joint, indicating that differences in these factors do not explain the observed racial differences. The association between BMI and hip OA is generally not as strong as the association between BMI and knee OA (21-23). BMI was not associated with radiographic features of hip OA in a large cross-sectional study of white individuals in Denmark (4). Occupational history was not evaluated in the current study, but has previously been shown to have variable association with hip OA in general, and none with specific radiographic features (4,24). However, there may be additional unidentified or unmeasured confounders that would account for the difference seen by race. There may be complex biomechanical differences by race in weight-bearing and loading of joints that are dependent not only on the hip, but also on the ipsilateral and contralateral knee and foot. Local or systemic differences in bone mineral density, not measured as part of the current study, could contribute to increased osteophyte formation in African American participants. An association between elevated bone mineral density and the presence, severity, and bilaterality of hip OA has been demonstrated, both at the OA-affected joint and systemically (25,26), suggesting that elevated bone mineral density may be involved in the pathogenesis of hip OA. As African Americans have higher overall bone density compared to whites, this may have a significant role in the observed racial differences.

Radiographic features of OA may be predictive of prognosis over time. Lanyon et al. found that the risk of severe hip OA was higher in siblings of index cases with atrophic hip OA and no osteophytosis, as compared to index cases with any degree of OST formation (6). Lane et al. showed that after eight years of follow up, elderly women with both acetabular and femoral osteophytes had five times the odds of progressing to total hip replacement (THR) compared to women with no osteophytes, and women with femoral osteophytes alone had nearly three times the odds of progressing to THR compared to women with no osteophytes (16). Additionally, there was an increased risk of progression of JSN and progression to THR at eight years among women with baseline superolateral JSN (16). Although the generalizability of these results is unknown, in the current study, AA women had increased odds of having the combination of acetabular and femoral osteophytes, more femoral osteophytes (especially in the medial compartment), and more frequent superior JSN (comparable to superolateral in the Lane study), raising the possibility that AA women may be at higher risk for progression compared to white women. This is particularly interesting in the context of rates of total hip replacement, which are much lower among AAs (13), previously thought related to lower prevalence of hip OA in AAs. If the prevalence of hip OA is comparable among AA and white participants, and the radiographic features of hip OA are suggestive of worse prognosis among AAs, then there is a potentially large unmet need for THR among AAs with hip OA. The current cross sectional study did not evaluate progression, but this could be assessed in future studies.

Limitations to the analysis include small numbers in the higher K-L grade categories, especially for K-L 3 and 4, and in the moderate and severe categories of joint space narrowing. Exclusion for inflammatory arthritis was based on hip and knee radiographs, as we did not have serologic data or other diagnostic criteria to assess; it is therefore possible that a small number of individuals with inflammatory arthritis were included, or a few with OA excluded. We did not assess hip symptoms, as we were primarily interested in structural differences for the current analysis, but symptomatic features could be assessed in future analyses. Data regarding bone mineral density were not available at the baseline examination. There was a slight difference in sample size between our unadjusted and adjusted models due to missing data for covariates; however, the estimates did not significantly change with adjustment, either with or without adjustment for injury, compared to the unadjusted odds ratios. Strengths of our study include the large sample size, as well as the single, experienced bone and joint radiologist reading all of the films. Additionally, due to the design of the Johnston County Osteoarthritis Project, we are able to recruit adequate numbers of AA subjects to assess differences by race. Anatomic measures are currently being evaluated on a subset of films to look for racial differences in femoral and pelvic anatomy that may contribute to the differences seen in the current study.

Conclusion

African Americans are not spared from hip rOA, and have more frequent and severe superior JSN and OST than whites. These findings may have implications for progression and prognosis of hip rOA, and are suggestive of a potentially large unmet need for hip replacement surgery in AAs, warranting further investigations into rates of progression and THR in this population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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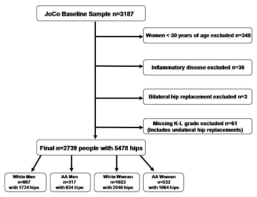

Figure 1. Flowsheet of Subject Inclusion

Diagram of inclusion and exclusion of subjects in the current study.

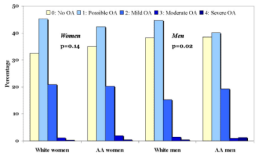

Figure 2. Frequencies of K-L grade by race among women and men

Frequencies of each Kellgren-Lawrence (K-L) grade (from 0-4) among white and African American (AA) women and men. The p values are for the comparison of the distribution of K-L grades within gender by race.

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Table 1

Characteristics of the sample, by sex and race.

	WOMEN (n=1555)			MEN (n=1184)		
	White (n=1023)* Mean (sd) or %†	AA (n=532) Mean (sd) or %	p value‡	White (n=867) Mean (sd) or %	AA (n=317) Mean (sd) or %	p value‡
Age (years)	64 (9)	64 (9)	0.99	61 (10)	60 (11)	0. 17
BMI (kg/m^2)	28 (6)	31 (7)	<**0.001**	28 (5)	27 (5)	**0.01**
Completed ≥ high school	60%	45%	<**0.001**	66%	46%	<**0.001**
Prior hip injury	3%	4%	0.18	3%	4%	0.57

BMI=body mass index, AA=African American

*n= number of participants in each category

†continuous variables (age, BMI) given as mean (sd), categorical variables (completed ≥ HS, prior hip injury) as % in category

‡for comparison by race within gender

Table 2

Unadjusted frequencies for joint space narrowing (JSN), subchondral cysts, and sclerosis at the hip, by sex and race.

FEATURE*	Women (number of hips=3110) †					Men (number of hips=2368) †				
	White		AA		p value‡	White		AA		p value‡
	n	%	n	%		n	%	n	%	
JSN										
Axial JSN										
None	1489	*73*	828	*78*	<**0.001**	1366	*79*	539	*85*	<**0.001**
Mild	539	*26*	214	*20*		359	*21*	86	*14*	
Moderate/severe	18	*1*	21	*2*		9	*1*	8	*1*	
Superior JSN										
None	1915	*94*	960	*90*	**0.004**	1594	*92*	533	*84*	<**0.001**
Mild	123	*6*	95	*9*		126	*7*	93	*15*	
Moderate/severe	8	*<1*	8	*1*		14	*1*	8	*1*	
Medial JSN										
None	2008	*98*	1027	*97*	0.06	1728	*99*	625	*99*	**0.01**
Mild	31	*2*	29	*3*		4	*<1*	5	*1*	
Moderate/severe	6	*<1*	4	*<1*		2	*<1*	4	*1*	
SUBCHONDRAL										
Cysts										
Absent	1971	*96*	1006	*95*	**0.02**	1626	*94*	583	*92*	0.12
Present	75	*4*	58	*5*		108	*6*	51	*8*	
Sclerosis										
Absent	1834	*90*	953	*90*	0.95	1395	*80*	484	*76*	**0.03**
Present	212	*10*	111	*10*		339	*20*	150	*24*	

*Given as number of affected hips (%); % may not add to 100 due to rounding

†For men, n=2367 for axial JSN; for women, axial and superior JSN n=3109, medial JSN n= 3105

‡for comparison by race within gender

Table 3

Unadjusted frequencies for medial and lateral osteophytes (OST) at the hip, by sex and race.

FEATURE*	Women (number of hips=3109) †					Men (number of hips=2368) †				
	White		AA		p value‡	White		AA		p value‡
	n	%	n	%		n	%	n	%	
Medial OST *(severity)* §										
None	1909	*93*	961	*90*	<**0.001**	1509	*87*	542	*85*	0.44
Mild	107	*5*	93	*9*		194	*11*	76	*12*	
Moderate/severe	27	*1*	8	*1*		31	*2*	16	*3*	
Medial OST *(location)*										
None	1905	*94*	961	*91*	**0.006**	1509	*87*	542	*85*	0.23
Acetabular only	54	*3*	35	*3*		81	*5*	26	*4*	
Femoral only	49	*2*	49	*5*		93	*5*	48	*8*	
Both	27	*1*	16	*2*		50	*3*	18	*3*	
Lateral OST *(severity)* §										
None	836	*41*	359	*34*	<**0.001**	849	*49*	251	*40*	<**0.001**
Mild	1030	*50*	575	*54*		747	*43*	317	*50*	
Moderate/severe	179	*9*	130	*12*		138	*8*	66	*10*	
Lateral OST *(location)*										
None	834	*41*	357	*34*	**0.001**	847	*49*	249	*39*	<**0.001**
Acetabular only	884	*43*	500	*47*		591	*34*	247	*39*	
Femoral only	73	*4*	47	*4*		101	*6*	32	*5*	
Both	248	*12*	157	*15*		193	*11*	103	*16*	

*Given as number of affected hips (%); % may not add to 100% due to rounding.

†For men, n=2363 for lateral OST and 2367 for medial OST; for women, n=3096 for medial OST, 3105 for any medial OST, 3100 for lateral OST, and 3109 for any lateral OST

‡for comparison by race within gender

§Includes either acetabular or femoral involvement

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Table 4

Adjusted ORs for individual radiographic features in AAs compared to Whites, by sex.

FEATURE	Severity	Women Adjusted n=3019‡ *aOR*(95% CI)*	Men Adjusted n=2296‡ *aOR*(95% CI)*
JSN			
Axial	*Mild*	**0.7 (0.6, 0.9)**	**0.6 (0.4, 0.9)**
	Mod/severe	**2.3 (1.1, 5.0)**	2.0 (0.7, 5.9)
Superior	*Mild*	**1.7 (1.2, 2.3)**	**2.0 (1.5, 2.8)**
	Mod/severe		
Medial	*Mild*	1.8 (0.9, 3.4)	**3.6 (1.0, 13.6)**
	Mod/severe		
SUBCHONDRAL CYSTS		**1.5 (1.0, 2.3)**	1.3 (0.8, 2.1)
SCLEROSIS		1.0 (0.7, 1.3)	1.3 (0.9, 1.7)
OST †			
Medial (severity)	*Mild*	**1.4 (1.0, 2.0)**	1.2 (0.8, 1.6)
	Mod/severe		
Medial, by location	*Acetabular*	1.1 (0.7, 2.0)	0.9 (0.5, 1.5)
	Femoral	**2.0 (1.2, 3.3)**	1.5 (0.9, 2.3)
	Both	1.0 (0.4, 2.5)	1.1 (0.5, 2.1)
Lateral (severity)	*Mild*	**1.2 (1.0, 1.5)**	**1.4 (1.1, 1.8)**
	Mod/severe		
Lateral, by location	*Acetabular*	1.2 (0.9, 1.4)	**1.4 (1.1, 1.9)**
	Femoral	1.5 (0.9, 2.4)	1.0 (0.6, 1.6)
	Both	**1.3 (1.0, 1.8)**	**1.8 (1.3, 2.7)**

* A single OR, for age, BMI, education, and prior injury, is given where the proportional odds assumption was satisfied, otherwise the generalized logit model OR is given, where the unaffected group is used asreferent.

† Includes either acetabular or femoral involvement

‡ For axial and superior JSN and for lateral OST by severity in women, n=3018; for medial JSN and medial OST by severity in women, n=3015; for medial OST by location in women, n=3006; for lateral OST by location in women, n=3010; ; for axial JSN and medial OST by location in men, n=2295; for lateral OST by location in men n=2291.